Third Year. 1885. Price, 12 Cts.

THE

Laboratory Handbook,

BY

JOHN HOWARD APPLETON, A. M.,
Professor of Chemistry in Brown University.

AUTHOR OF

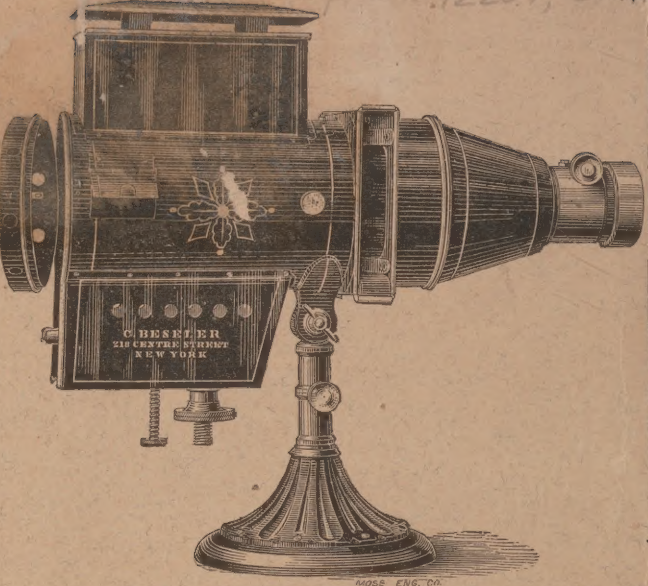
The Young Chemist,
Qualitative Chemical Analysis,
Quantitative Chemical Analysis.

PROFESSOR ROBERT BUNSEN OF HEIDELBERG.

PROVIDENCE, R. I.:
GORDON ROSCOE & COMPANY,
PUBLISHERS.
1885.

.12207, item 2

THE BESELER MAGIC LANTERN,



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1-4 size Objective,	14 ft. distant,	gives a	7 ft.	Picture	1-2 size Objective,	60 ft. distant,	gives a	17 1-2 ft.	Picture
1-4 "	20 "	"	10	"	2-3 "	57 "	"	15	"
1-3 "	36 "	"	12	"	2-3 "	64 "	"	17	"
1-3 "	50 "	"	19	"	4-4 "	80 "	"	16	"
1-2 "	50 "	"	14	"	4-4 "	100 "	"	22	"

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THE

LABORATORY HANDBOOK.

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CONTENTS:

E. A. JOHNSON & CO., PRINTERS, 57 WEYBOSSET STREET, PROVIDENCE, R. I.

THE laws of nature are the thoughts of God.

OERSTED.

CALENDAR.

1885	*Sunday*	*Monday*	*Tuesday*	*Wednes.*	*Thursd.*	*Friday*	*Saturd.*	1885	*Sunday*	*Monday*	*Tuesday*	*Wednes.*	*Thursd.*	*Friday*	*Saturd.*
Jan.	...	...	...	...	1	2	3	July	...	...	...	1	2	3	4
	4	5	6	7	8	9	10		5	6	7	8	9	10	11
	11	12	13	14	15	16	17		12	13	14	15	16	17	18
	18	19	20	21	22	23	24		19	20	21	22	23	24	25
	25	26	27	28	29	☺	31		☺	27	28	29	30	31	...
	...	...	...	...	...	...	...	Aug.	...	...	...	...	...	...	1
Feb.	1	2	3	4	5	6	7		2	3	4	5	6	7	8
	8	9	10	11	12	13	14		9	10	11	12	13	14	15
	15	16	17	18	19	20	21		16	17	18	19	20	21	22
	22	23	24	25	26	27	☺		23	24	☺	26	27	28	29
	...	...	...	...	...	...	...		30	31	...	...	...	...	...
Mar.	1	2	3	4	5	6	7	Sept.	...	...	1	2	3	4	5
	8	9	10	11	12	13	14		6	7	8	9	10	11	12
	15	16	17	18	19	20	21		13	14	15	16	17	18	19
	22	23	24	25	26	27	28		20	21	22	23	☺	25	26
	29	☺	31	...	...	...	...		27	28	29	30	...	...	...
Apr.	...	...	...	1	2	3	4	Oct.	...	...	...	...	1	2	3
	5	6	7	8	9	10	11		4	5	6	7	8	9	10
	12	13	14	15	16	17	18		11	12	13	14	15	16	17
	19	20	21	22	23	24	25		18	19	20	21	22	☺	24
	26	27	28	☺	30	...	...		25	26	27	28	29	30	31
May	...	...	...	...	...	1	2		...	...	...	...	...	...	...
	3	4	5	6	7	8	9	Nov.	1	2	3	4	5	6	7
	10	11	12	13	14	15	16		8	9	10	11	12	13	14
	17	18	19	20	21	22	23		15	16	17	18	19	20	21
	24	25	26	27	☺	29	30		☺	23	24	25	26	27	28
	31	...	...	...	...	...	...		29	30	...	...	...	...	...
June	...	1	2	3	4	5	6	Dec.	...	...	1	2	3	4	5
	7	8	9	10	11	12	13		6	7	8	9	10	11	12
	14	15	16	17	18	19	20		13	14	15	16	17	18	19
	21	22	23	24	25	26	☺		20	☺	22	23	24	25	26
	28	29	30	...	...	...	...		27	28	29	30	31	...	...

If all the year were playing holidays
To sport would be as tedious as to work.

FIRST PART-HENRY IV.

EDITORIAL GREETING.

The third annual issue of

THE LABORATORY HANDBOOK

is now offered for the favorable consideration of the scientific world. Many of our friends have found the previous numbers serviceable: they will discover in this one several new features that we trust will merit their approval.

We are already indebted to many users of the little book for valuable advice; we shall be happy to receive in the future such other suggestions as any of our readers may offer, in the hope of yet further improving the HANDBOOK.

THE EDITOR.

ASTRONOMICAL NOTES FOR 1885.

ECLIPSES.

In the year 1885, there will be four eclipses, two of the sun and two of the moon.

I. An annular eclipse of the sun on March 16, visible at Washington as a partial eclipse.

CIRCUMSTANCES OF THE ECLIPSE.

	H. M.	
Eclipse begins	10 09	A. M.
Central eclipse begins	11 31	"
Central eclipse at noon	1 06	P. M.
Central eclipse ends	1 43	"
Eclipse ends	3 06	"

II. A partial eclipse of the moon on March 30, invisible at Washington; visible in the Western Pacific Ocean, Asia and the eastern portion of Europe and Africa.

III. A total eclipse of the sun on September 8, invisible at Washington, but visible in the South Pacific Ocean.

IV. A partial eclipse of the moon on September 23–24, visible at Washington; also on the Atlantic Ocean, North and South America, and the Pacific Ocean.

TIMES OF THE PHASES.

	H. M.	
Moon enters penumbra	11 52	P. M.
Moon enters shadow	1 00	A. M.
Middle of the eclipse	2 40	"
Moon leaves shadow	4 14	"
Moon leaves penumbra	5 28	"

First Month.

JANUARY						
S	M	T	W	T	F	S
...	...	...	...	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31
...	...	...	...	...	...	...

31 Days.

1885.

MEMORANDA.

Second Month.

FEBRUARY						
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
...	...	...	...	...	...	...
...	...	...	...	...	...	...

28 Days.

1885.

MEMORANDA.

Third Month.

MARCH						
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	...	...	...	...
...	...	...	...	...	...	...

31 Days.

1885.

MEMORANDA.

Fourth Month.

APRIL						
S	M	T	W	T	F	S
...	...	...	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	...	...
...	...	...	...	...	...	...

30 Days.

1885.

MEMORANDA.

Fifth Month. 31 Days.

MAY						
S	M	T	W	T	F	S
...	...	...	...	...	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	...	...	...	...	...	...

1885.

MEMORANDA.

Sixth Month.

JUNE						
S	M	T	W	T	F	S
...	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	...	...	...	...
...	...	...	...	...	...	...

30 Days.

1885.

MEMORANDA.

Seventh Month. 31 Days.

JULY						
S	M	T	W	T	F	S
...	...	...	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	...
...	...	...	...	...	...	...

1885.

MEMORANDA.

Eighth Month. 31 Days.

AUGUST						
S	M	T	W	T	F	S
...	...	...	...	...	...	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31	...	...	...	...	...

1885.

MEMORANDA.

Ninth Month. 30 Days.

SEPTEMBER						
S	M	T	W	T	F	S
...	...	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	...	...	...
...	...	...	...	...	...	...

1885.

MEMORANDA.

Tenth Month.

OCTOBER						
S	M	T	W	T	F	S
...	...	...	...	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31
...	...	...	...	...	...	...

31 Days.

1885.

MEMORANDA.

Eleventh Month. 30 Days.

NOVEMBER						
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	...	...	...	...	...
...	...	...	...	...	...	...

1885.

MEMORANDA.

Twelfth Month. 31 Days.

DECEMBER						
S	M	T	W	T	F	S
...	...	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	...	...
...	...	...	...	...	...	...

1885.

MEMORANDA.

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Over $30 and not exceeding $40	1 25
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TABLE BASED ON THE LATEST REVISION OF

ATOMIC AND MOLECULAR WEIGHTS.

(Derived from Professor F. W. Clarke's figures.)

NAMES OR FORMULAS.	WEIGHTS.	Approxim'e Weights.
Aluminum, Al	27.0090	27.
Al_2O_3	101.9079	101.9
$Al_2(SO_4)_3\ (NH_4)_2\ SO_4\ 24H_2O$	904.5280	904.5
Antimony, Sb	119.9550	120.
Sb_2O_4	303.7632	303.8
Sb_2S_3	335.8620	335.9
$K\ Sb\ O\ H_2O_4C_4H_2\ O_2 + \frac{1}{2}\ H_2O$	331.5931	331.6
Arsenic, As	74.9180	74.9
As_2O_3	197.7259	197.7
As_2S_3	245.7880	245.8
$NH_4\ Mg\ As\ O_4\ 12\ H_2O$	396.3108	396.3
$Mg_2As_2O_7$	309.4971	309.5
Barium, Ba	136.7630	136.8
$BaCl_2 + 2H_2O$	243.4296	243.4
$BaSO_4$	232.6002	232.6
Bismuth, Bi	207.5230	207.5
Bi_2O_3	462.9359	462.9
$BiONO_3$	285.3972	285.4
Boron, Bo	10.9410	10.9
Bromine, Br	79.7680	79.8
KBr	118.7870	118.8
AgBr	187.4430	187.4
Cadmium, Cd	111.8350	111.8
CdO	127.7983	127.8
CdS	143.8190	143.8
Cæsium, Cs	132.5830	132.6
Calcium, Ca	39.9900	40.
CaO	55.9533	56.
$CaCO_3$	99.8535	99.9
$CaSO_4$	135.8272	135 8
Carbon, C	11.9736	12.
CO	27.9369	27.9
CO_2	43.9002	43.9
Cerium, Ce	140.4240	140.4
Chlorine, Cl	35.3700	35.4
AgCl	143.0450	143.
NaCl	58.3680	58.4
Chromium, Cr	52.0090	52.
Cr_2O_3	151.9079	151.9
$K_2Cr_2O_7$	293.7991	293.8
$K_2S\ O_4\ Cr_2(SO_4)_3\ 24H_2O$	996.5240	996.5

NAMES OR FORMULAS.	WEIGHTS.	Approxim'e Weights.
Cobalt, Co	58.8870	58.9
Copper, Cu	63.1730	63.2
CuO	79.1363	79.1
$CuSO_4\ 5H_2O$	248.8267	248.8
Didymium, D	144.5730	144 6
Erbium, E	165.8910	165.9
Fluorine, Fl	18.9840	19.
Gallium, Ga	68.8540	68.9
Glucinum, G	9 0850	9.1
Gold, Au	196.1550	196.2
Hydrogen, H	1.0000	1.
H_2O	17.9633	18.
Indium, In	113 3980	113.4
Iodine, I	126.5570	126.6
KI	165.5760	165.6
AgI	234.2320	234.2
Iridium, Ir	192.6510	192.7
Iron, Fe	55.9130	55.9
Fe_2O_3	159.7159	159.7
$FeSO_4 + 7H_2O$	277.4933	277.5
$Fe\ SO_4 + (NH_4)_2\ SO_4\ 6H_2O$	391.4092	391.4
$Fe_2(SO_4)_3\ (NH_4)_2\ SO_4\ 24H_2O$	962.3360	962.3
Lanthanum, La	138.5260	138.5
Lead, Pb	206.4710	206.5
PbO	222.4343	222.4
PbS	238.4550	238.5
$Pb(NO_3)_2$	330.2928	330.3
$PbSO_4$	302.3082	302.3
Lithium, Li	7.0073	7.
Magnesium, Mg	23 9500	24.
MgO	39.9223	39.9
$MgSO_4 + 7H_2O$	245.5393	245.5
$Mg_2P_2O_7$	221.5771	221.6
Manganese, Mn	53.9060	53.9
MnO	69.8693	69.9
MnO_2	85.8326	85.8
Mn_3O_4	225.5712	225.6

TABLE BASED ON THE LATEST REVISION OF

ATOMIC AND MOLECULAR WEIGHTS.

(*Continued.*)

NAMES OR FORMULAS.	WEIGHTS.	Approxim'e Weights.
Mercury, Hg	199.7120	199.7
$HgCl_2$	270.4520	270.5
HgS	231.6960	231.7
Molybdenum, Mo	95.5270	95.5
Nickel, Ni	57 9280	57.9
NiO	73.8913	73.9
$NiSO_4$ $(NH_4)_2SO_4$ $6H_2O$	393.4242	393.4
Niobium, Nb	93.8120	93.8
Nitrogen, N.	14 0210	14.
N_2O_5	107.8585	107.9
HNO_3	62.9109	62.9
KNO_3	100.9299	100.9
NH_3	17.0210	17.
NH_4	18.0210	18.
NH_4Cl	53.3910	53.4
NH_4OH	34.9843	35.
$(NH_4)_2PtCl_6$	442.6770	442.7
Osmium, Os	198.4940	198.5
Oxygen, O	15.9033	16.
O_2	31.9266	31.9
O_3	47.8899	47.9
O_4	63.8532	63.9
O_5	79.8165	79.8
O_6	95.7798	95.8
O_7	111.7431	111.7
O_8	127.7064	127.7
O_9	143.6697	143.7
Palladium, Pd	105.7370	105.7
Phosphorus, P	30.9580	31.
P_2O_5	141.7325	141.7
$Mg_2P_2O_7$	221.5771	221.6
Platinum, Pt	194.4150	194.4
K_2PtCl_6	484.6730	484.7
$(NH_4)_2PtCl_6$	442.6770	442.7
Potassium, K	39.0190	39.
K_2O	94.0013	94.
KCl	74.3500	74 4
K_2PtCl_6	484.6730	484.7
K_2SO_4	173.8752	173.9
Rhodium, Rh	104.0550	104.1

NAMES OR FORMULAS.	WEIGHTS.	Approxim'e Weights.
Rubidium, Rb	85.2510	85.3
Ruthenium, Ru	104.2170	104.2
Scandium, Sc	43.9800	44.
Selenium, Se	78.7970	78.8
Silicon, Si	28.1950	28.2
SiO_2	60 1216	60.1
Silver, Ag	107.6750	107.7
$AgCl$	143.0450	143.
$AgNO_3$	169.5859	169.6
Sodium, Na	22.9980	23.
$NaCl$	58.3680	58.4
Na_2CO_3	105.8595	105.9
Na_2O	61.9593	62.
Strontium, Sr	87.3740	87.4
$SrSO_4$	183.2112	183.2
Sulphur, S	31.9840	32.
SO_2	63.9106	63.9
SO_3	79.8739	79.9
SO_4	95.8372	95.8
H_2SO_4	97.8372	97.8
Tantalum, Ta	182.1440	182.1
Tellurium, Te	127.9600	128.
Thallium, Tl	203 7150	203.7
Thorium, Th	233.4140	233.4
Tin, Sn	117.6980	117.7
$SnCl_2+2H_2O$	224.3646	224.4
SnO_2	149 6246	149.6
*Titanium, Ti	47.9997	48.
Tungsten, W	183.6100	183.6
Uranium, U	238.4820	238.5
Vanadium, Va	51.2560	51.3
Ytterbium, Yb	172.7610	172.8
Yttrium, Y	89.8160	89.8
Zinc, Zn	64.9045	64.9
ZnO	80.8678	80.9
$ZnSO_4+7H_2O$	286.4848	286.5
Zirconium, Zr.	89.3670	89.4

*Thorpe, T. E., Chemical News, 48; 251.

TABLES OF WEIGHTS AND MEASURES.

ENGLISH WEIGHTS.

TROY WEIGHT.

Pound.	*Ounces.*	*Pennyweights.*	*Grains.*		*French Grammes.*
1	12	240	5760	=	373.2419
	1	20	480	=	31.1035
		1	24	=	1.5552

APOTHECARIES' WEIGHT.

lb. *Pound.*	℥ *Ounces.*	ʒ *Drachms.*	℈ *Scruples.*	gr. *Grains.*		*French Grammes.*
1	12	96	288	5760	=	373.2419
	1	8	24	480	=	31.1035
		1	3	60	=	3.8879
			1	20	=	1.2959
				1	=	.0648

AVOIRDUPOIS WEIGHT.

Pound.	*Ounces.*	*Drachms.*	*Grains.*		*French Grammes.*
1	16	256	7000	=	453.5926
	1	16	437.5	=	28.3495
		1	27.343	=	1.7718

METRIC MEASURES.

MEASURES OF LENGTH.

1 Millimetre	=	0.001 of a metre.			
1 Centimetre	=	0.010 of a metre.			
1 Decimetre	=	0.100 of a metre	=	about 4 inches.
1 Metre	=	**1.000 Metre**	=	**39.37 inches.**
1 Decametre	=	10.000 metres.		
1 Hectometre	=	100.000 metres.		
1 Kilometre	=	1,000.000 metres	=	about ⅝ of a mile.
1 Myriametre	=	10,000.000 metres	=	about 6 1/5 miles.

MEASURES OF SURFACE.

1 Centiare	=	1 Square metre	=	about 1 1/5 square yards.
1 Are	=	**100 Square metres.**		
1 Hectare	=	10,000 Square metres	=	about 2½ acres.

MEASURES OF VOLUME.

1 Cubic Metre	=	1000 Cubic Decimetres.
	=	1000 Litres, or one Kilolitre.
	=	1 Stere.

MEASURES OF CAPACITY.

1 Litre	=	1 cubic decimetre, or 1000 cubic centimetres	=	**about 1 quart.**

MEASURES OF WEIGHT.

1 Milligramme	=	0.001 of a gramme	=	about 1/65 of a grain.
1 Centigramme	=	0.010 of a gramme.		
1 Decigramme	=	0.100 of a gramme.		
1 Gramme	=	**1.000 Gramme**	=	**about 15½ grains.**
1 Decagramme	=	10.000 grammes.		
1 Hectogramme	=	100.000 grammes.		
1 Kilo(gramme)	=	1000.000 grammes	=	about 2 1/5 lbs.
1 Tonneau	=	1000. Kilo's	=	about 1 ton.

ALPHABETICAL TABLE OF EQUIVALENT VALUES OF

WEIGHTS AND MEASURES.

1 Are = 100 sq. metres	119.6 sq. yards.
1 Centiare = 1 sq. metre, = 100 sq. centimetres	1550. sq. inches.
1 Centimetre = $\frac{1}{100}$ of a metre	.3937 inches.
1 Cubic centimetre; (of dist. water, weighs 1 gm.)	.0610 cub. inches.
1 Cubic decimetre, (same as 1 litre)	1000 C. C.
1 " " of distilled water, weighs 1000 gms., or	1 kilogramme.
1 " " *in English* or imperial measure	.8804 quarts.
1 " " *in American* or wine measure	1.0567 quarts.
1 Cubic foot (1728 cubic inches)	28,315.3119 cub. cent.
1 " " of water (at 62° F.) weighs	62.3210 lbs. Av.
1 Cubic inch	16.3861 cub. cent.
1 " " of water (at 62 F.) weighs	252.458 grains.
1 " " of water (at 60° F.) weighs	252.5 grains.
1 Cubic metre (1 Stere), = 1,000,000. C. C., or	1000. litres.
1 Fluid ounce, imperial, = 28.4 C. C.	1.7329 cub. inches.
1 " " wine measure, = 29 5 C. C.	1.8047 cub. inches.
1 " " imperial, of water (62° F.) weighs	437.5 grains.
1 " " wine measure, of water (60° F.) weighs	456.0 grains.
1 Foot	30.48 centimetres.
1 Gallon, imperial, = 277.274 cubic inches	4.5435 litres.
1 " " of water, weighs (62° F.) 10 lbs. or	70,000 grains.
1 Gallon, wine measure, = 231. cubic inches	3 7852 litres.
1 " " " of water, weighs (60° F.) 8.34 lbs. or	58,372.2 grains.
1 Gramme (weight of 1 C. C. of dist. water, 4° C.)	15.4323 grains.
1 Inch	2.54 centimetres.
1 Kilogramme (1000 grammes)	2.2046 lbs. Av.
1 Litre (see cubic decimetre).	
1 Metre (1 40-mill'th of Earth's meridian) 3 ft. 3 in. ⅜ in., nearly.	39.3708 inches.
1 Pint, wine meas., = 16 fluid oz. = of water (60° F.) 7296.5 gr.	473.148 cub. cent.
1 " imperial, = 20 fluid oz. = of water (62° F.) 8750. gr.	567.932 cub. cent.
1 Quart, wine measure, = 32 fluid ounces	.9463 litres.
1 " imperial, = 40 fluid ounces	1.1358 litres.
1 Ton Avoirdupois (2000 lbs.)	29,166⅔. oz. Troy.
1 Tonneau, = 1,000,000 gms	1000 kilo's.

TABLE SHOWING CORRESPONDING DEGREES ON THE SCALES OF THE FAHRENHEIT AND CENTIGRADE

THERMOMETERS.

FAHR.	CENT.	FAHR.	CENT.	FAHR.	CENT.	FAHR.	CENT.	FAHR.	CENT.	FAHR.	CENT.
32	0.	62	16.6	91.4	33.	121	49.4	152	66.6	182	83.3
33	.5	62.6	17.	92	33.3	122	50	152.6	67	183	83.8
33.8	1.	63	17.2	93	33.8	123	50.5	153	67.2	183.2	84
34	1.1	64	17.7	93.2	34.	123.8	51.	154	67.7	184	84.4
35	1.6	64.4	18.	94	34.4	124	51.1	154.4	68.	185	85
35.6	2.	65	18.3	95	35.	125	51.6	155	68.3	186	85.5
36	2.2	66	18.8	96	35.5	125.6	52.	156	68.8	186.8	86.
37	2.7	66.2	19.	96.8	36.	126	52.2	156.2	69.	187	86.1
37.4	3.	67	19.4	97	36.1	127	52.7	157	69.4	188	86.6
38	3.3	68	20.	98	36.6	127.4	53.	158	70.	188.6	87
39	3.8	69	20.5	98.6	37.	128	53.3	159	70.5	189	87.2
39.2	4.	69.8	21.	99	37.2	129	53.8	159.8	71	190	87.7
40	4.4	70	21.1	100	37.7	129.2	54.	160	71.1	190.4	88
41	5.	71	21.6	100.4	38.	130	54.4	161	71.6	191	88.3
42	5.5	71.6	22.	101	38.3	131	55.	161.6	72.	192	88.8
42.8	6.	72	22.2	102	38.8	132	55.5	162	72.2	192.2	89.
43	6.1	73	22.7	102.2	39.	132.8	56.	163	72.7	193	89.4
44	6.6	73.4	23.	103	39.4	133	56.1	163.4	73.	194	90
44.6	7.	74	23.3	104	40.	134	56.6	164	73.3	195	90.5
45	7.2	75	23.8	105	40.5	134.6	57.	165	73.8	195.8	91.
46	7.7	75.2	24.	105.8	41.	135	57.2	165.2	74.	196	91.1
46.4	8.	76	24.4	106	41.1	136	57.7	166	74.4	197	91.6
47	8.3	77	25.	107	41.6	136.4	58.	167	75.	197.6	92.
48	8.8	78	25.5	107.6	42.	137	58.3	168	75.5	198	92.2
48.2	9.	78.8	26.	108	42.2	138	58.8	168.8	76.	199	92.7
49	9.4	79	26.1	109	42.7	138.2	59.	169	76.1	199.4	93.
50	10.	80	26.6	109.4	43.	139	59.4	170	76.6	200	93.3
51	10.5	80.6	27.	110	43.3	140	60.	170.6	77.	201	93.8
51.8	11.	81	27.2	111	43.8	141	60.5	171	77.2	201.2	94.
52	11.1	82	27.7	111.2	44.	141.8	61.	172	77.7	202	94.4
53	11.6	82.4	28.	112	44.4	142	61.1	172.4	78.	203	95.
53.6	12.	83	28.3	113	45.	143	61.6	173	78.3	204	95.5
54	12.2	84	28.8	114	45.5	143.6	62.	174	78.8	204.8	96.
55	12.7	84.2	29.	114.8	46.	144	62.2	174.2	79.	205	96.1
55.4	13.	85	29.4	115	46.1	145	62.7	175	79.4	206	96.6
56	13.3	86	30.	116	46.6	145.4	63.	176	80.	206.6	97.
57	13.8	87	30.5	116.6	47.	146	63.3	177	80.5	207	97.2
57.2	14	87.8	31.	117	47.2	147	63.8	177.8	81.	208	97.7
58	14.4	88	31.1	118	47.7	147.2	64.	178	81.1	208.4	98.
59	15.	89	31.6	118.4	48.	148	64.4	179	81.6	209	98.3
60	15.5	89.6	32.	119	48.3	149	65.	179.6	82.	210	98.8
60.8	16.	90	32.2	120	48.8	150	65.5	180	82.2	210.2	99.
61	16.1	91	32.7	120.2	49.	150.8	66.	181	82.7	211	99.4
						151	66.1	181.4	83.	212	100

SPECIFIC GRAVITIES OF SOLID AND LIQUID ELEMENTS. (WATER=1.)

Lithium	.59	Zinc	7.10 — 7.20
Potassium	.86	Tin	7.29 — 7.30
Sodium	.97	Iron	7.79 — 7.84
Chlorine (liquid)	1.33	Manganese	8.01 — 8.03
Calcium	1.58	Cobalt	8.49 — 8.51
Magnesium	1.70 — 1.74	Nickel	8.60 — 8.82
Phosphorus	1.83 — 1.96	Cadmium	8.45 — 8.69
Sulphur	1.98 — 2.07	Molybdenum	8.62 — 8.64
Glucinum	2.10	Copper	8.93 — 8.95
Carbon	2.27 — 3.52	Bismuth	9.78 — 9.80
Silicon	2.49	Silver	10.40 — 10.57
Aluminum	2.50 — 2.67	Rhodium	11.00 — 11.20
Strontium	2.54	Lead	11.33 — 11.39
Bromine (liquid)	2.99 — 3.19	Palladium	11.80
Selenium	4.28 — 4.80	Mercury (liquid.)	13.60
Iodine	4.95	Tungsten	17.20 — 18.30
Arsenic	5.63 — 5.67	Uranium	18.40
Tellurium	6.18 — 6.24	Gold	19.26 — 19.34
Antimony	6.72	Platinum	21.50
Chromium	7.01	Iridium	21.80

SIMPLE FORMULAS FOR CALCULATING AREAS, SURFACES AND VOLUMES.

$\pi = 3.1416.$

PLANE AREAS.

Triangle, (altitude, *a*; base, *b*) .... Area $= \frac{1}{2}ab.$

Circle, (radius, R; diameter, D) .... " $= \pi R^2$ or $\frac{1}{4}\pi D^2$

Ellipse, (semi-axes, *a* and *b*) .... " $= \pi ab.$

SURFACES OF SOLIDS.

Sphere, (radius, R; diameter, D) ..... Surface $= 4\pi R^2$ or $\pi D^2.$

Cylinder, (radius, R; height, *h*) ...... " $= 2(\pi R^2) + (2\pi R)h = 2\pi R(R+h).$

VOLUMES OF SOLIDS.

Sphere, (radius, R; diameter, D) .... Volume $= \frac{4}{3}\pi R^3$ or $\frac{1}{6}\pi D^3.$

Cylinder or Prism, (height, *h*; area of base, *a*) .... " $= ah.$

Cone or Pyramid, (height, *h*; area of base, *a*) .... " $= \frac{1}{3}ah.$

THE C. G. S. SYSTEM OF UNITS.

The C. G. S. System of Units is the result of an attempt to express all quantities with which physical science deals, in terms of three fundamental units:—

A Unit of Length, the centimetre:

A Unit of Mass, the gramme;

A Unit of Time, the second.

From these the following units are derived:—

Unit of *Surface;* the square centimetre.

" " *Volume;* the cubic centimetre.

" " *Velocity;* the velocity of one centimetre per second.

" " *Acceleration;* the acceleration which imparts unit velocity to a body, in one second.

" " *Force;* the dyne; the force, which, acting on a gramme mass for one second, imparts to it a unit of velocity.

" " *Work;* the erg; the work done by a dyne working through one centimetre.

" " *Energy;* also the erg: since the energy of a body is measured by the amount of work it can do.

" " *Heat;* the amount of heat required to raise one gramme of water from 0° to 1° C.

" " *Magnetic Strength;* a magnetic pole has unit strength when it repels a similar pole of equal strength, one centimetre distant, with the force of a dyne.

" " *Electric Current* (electro-magnetic system); a current of such strength that one centimetre of its circuit, bent so that every point of it is one centimetre distant from a unit magnetic pole, exerts upon this pole the force of a dyne.

" " *Electric Quantity* (electro-magnetic system); the quantity conveyed by a unit current in one second.

" " *Difference of Potential* (electro magnetic system); two points have unit difference of potential when one erg of work must be expended to bring a unit of + electricity from one to the other against the electric force.

" " *Electric Resistance* (electro-magnetic system); a conductor possesses unit resistance when a unit difference of potential between its ends, causes a unit current to flow through it.

ALPHABETICAL TABLE OF UNITS USED IN PHYSICAL SCIENCE.

Ampère; unit of electric current; 10^{-1} C. G. S. units; the current produced by the difference of potential of a volt through the resistance of an ohm.

Calorie; French unit of heat; quantity of heat required to raise one kilogramme of water from 0° to 1° C; equals 3 968 Eng. units of heat. (See *Heat, English unit of.*)

Capacity, unit of electric. See *Farad.*

Cheval-de-vapeur. See *Force-de-cheval.*

Coulomb; unit of electric quantity; 10^{-1} C. G. S. units; quantity conveyed by the current of an ampère in a second.

Current, unit of electric. See *Ampère.*

Electro-motive force, unit of. See *Volt.*

Farad; unit of electrtc capacity; 10^{-9} C. G. S. units; quantity which, with the electromotive force of a volt, would flow through the resistance of an ohm in one second.

Foot-pound; English unit of work; work required to raise one pound through one foot in opposition to the force of gravity.

Force, units of. See *Kilogramme* and *Pound.*

Force-de cheval; French unit of power; .9864 horse-power; power of doing 75 kilogrammetres (542.5 foot-pounds) of work per second.

Heat, English unit of; heat required to raise one pound of water from 32° to 33° F. (See *Calorie.*)

Horse-power; English unit of power; power required to perform 550 foot-pounds of work per second.

Kilogramme; French unit of mass, and also of force. (See *Pound.*)

Kilogrammetre; French unit of work; work required to raise one kilogramme of mass through one metre in opposition to force of gravity.

Mass, units of. See *Kilogramme* and *Pound.*

Ohm; unit of electric resistance; 10^9 C. G. S units; is the resistance offered to a current of electricity by a wire of pure silver or copper one millimetre in diameter and 48.61 metres long at 65° F (18 3° C).

Potential, unit difference of. See *Volt.*

Pound; English unit of mass; regarded as a *weight* it is used also as the unit of force, i. e. the force exercised by the mass of a pound (where g = 981 : London).

Power, unit of. See *Force-de-cheval* and *Horse-power.*

Power, unit of electric. See *Watt.*

Quantity, unit of electric. See *Coulomb.*

Quantity, unit of magnetic. See *Weber.*

Resistance, unit of electric. See *Ohm.*

Volt; unit of electro-motive force; 10^8 C. G. S. units; equals 9208 of the force of one Daniell cell.

Watt, unit of electric power; 10^7 C. G. S. units; power exerted by the current of an ampère through the difference of potential of a volt.

Weber; unit of magnetic quantity; 10^8 C. G. S. units.

Work, units of. See *Foot-pound* and *Kilogrammetre.*

TABLE OF LOGARITHMS.

Nat. Numb.	0	1	2	3	4	5	6	7	8	9	Proportional Parts. 1	2	3	4	5	6	7	8	9
10	0000	0043	0086	0128	0170	0212	0253	0294	0334	0374	4	8	12	17	21	25	29	33	37
11	0414	0453	0492	0531	0569	0607	0645	0682	0719	0755	4	8	11	15	19	23	26	30	34
12	0792	0828	0864	0899	0934	0969	1004	1038	1072	1106	3	7	10	14	17	21	24	28	31
13	1139	1173	1206	1239	1271	1303	1335	1367	1399	1430	3	6	10	13	16	19	23	26	29
14	1461	1492	1523	1553	1584	1614	1644	1673	1703	1732	3	6	9	12	15	18	21	24	27
15	1761	1790	1818	1847	1875	1903	1931	1959	1987	2014	3	6	8	11	14	17	20	22	25
16	2041	2068	2095	2122	2148	2175	2201	2227	2253	2279	3	5	8	11	13	16	18	21	24
17	2304	2330	2355	2380	2405	2430	2455	2480	2504	2529	2	5	7	10	12	15	17	20	22
18	2553	2577	2601	2625	2648	2672	2695	2718	2742	2765	2	5	7	9	12	14	16	19	21
19	2788	2810	2833	2856	2878	2900	2923	2945	2967	2989	2	4	7	9	11	13	16	18	20
20	3010	3032	3054	3075	3096	3118	3139	3160	3181	3201	2	4	6	8	11	13	15	17	19
21	3222	3243	3263	3284	3304	3324	3345	3365	3385	3404	2	4	6	8	10	12	14	16	18
22	3424	3444	3464	3483	3502	3522	3541	3560	3579	3598	2	4	6	8	10	12	14	15	17
23	3617	3636	3655	3674	3692	3711	3729	3747	3766	3784	2	4	6	7	9	11	13	15	17
24	3802	3820	3838	3856	3874	3892	3909	3927	3945	3962	2	4	5	7	9	11	12	14	16
25	3979	3997	4014	4031	4048	4065	4082	4099	4116	4133	2	3	5	7	9	10	12	14	15
26	4150	4166	4183	4200	4216	4232	4249	4265	4281	4298	2	3	5	7	8	10	11	13	15
27	4314	4330	4346	4362	4378	4393	4409	4425	4440	4456	2	3	5	6	8	9	11	13	14
28	4472	4487	4502	4518	4533	4548	4564	4579	4594	4609	2	3	5	6	8	9	11	12	14
29	4624	4639	4654	4669	4683	4698	4713	4728	4742	4757	1	3	4	6	7	9	10	12	13
30	4771	4786	4800	4814	4829	4843	4857	4871	4886	4900	1	3	4	6	7	9	10	11	13
31	4914	4928	4942	4955	4969	4983	4997	5011	5024	5038	1	3	4	6	7	8	10	11	12
32	5051	5065	5079	5092	5105	5119	5132	5145	5159	5172	1	3	4	5	7	8	9	11	12
33	5185	5198	5211	5224	5237	5250	5263	5276	5289	5302	1	3	4	5	6	8	9	10	12
34	5315	5328	5340	5353	5366	5378	5391	5403	5416	5428	1	3	4	5	6	8	9	10	11
35	5441	5453	5465	5478	5490	5502	5514	5527	5539	5551	1	2	4	5	6	7	9	10	11
36	5563	5575	5587	5599	5611	5623	5635	5647	5658	5670	1	2	4	5	6	7	8	10	11
37	5682	5694	5705	5717	5729	5740	5752	5763	5775	5786	1	2	3	5	6	7	8	9	10
38	5798	5809	5821	5832	5843	5855	5866	5877	5888	5899	1	2	3	5	6	7	8	9	10
39	5911	5922	5933	5944	5955	5966	5977	5988	5999	6010	1	2	3	4	5	7	8	9	10

TABLE OF LOGARITHMS.

Nat. Numb.	0	1	2	3	4	5	6	7	8	9	PP 1	PP 2	PP 3	PP 4	PP 5	PP 6	PP 7	PP 8	PP 9
40	6021	6031	6042	6053	6064	6075	6085	6096	6107	6117	1	2	3	4	5	6	8	9	10
41	6128	6138	6149	6160	6170	6180	6191	6201	6212	6222	1	2	3	4	5	6	7	8	9
42	6232	6243	6253	6263	6274	6284	6294	6304	6314	6325	1	2	3	4	5	6	7	8	9
43	6335	6345	6355	6365	6375	6385	6395	6405	6415	6425	1	2	3	4	5	6	7	8	9
44	6435	6444	6454	6464	6474	6484	6493	6503	6513	6522	1	2	3	4	5	6	7	8	9
45	6532	6542	6551	6561	6571	6580	6590	6599	6609	6618	1	2	3	4	5	6	7	8	9
46	6628	6637	6646	6656	6665	6675	6684	6693	6702	6712	1	2	3	4	5	6	7	7	8
47	6721	6730	6739	6749	6758	6767	6776	6785	6794	6803	1	2	3	4	5	5	6	7	8
48	6812	6821	6830	6839	6848	6857	6866	6875	6884	6893	1	2	3	4	4	5	6	7	8
49	6902	6911	6920	6928	6937	6946	6955	6964	6972	6981	1	2	3	4	4	5	6	7	8
50	6990	6998	7007	7016	7024	7033	7042	7050	7059	7067	1	2	3	3	4	5	6	7	8
51	7076	7084	7093	7101	7110	7118	7126	7135	7143	7152	1	2	3	3	4	5	6	7	8
52	7160	7168	7177	7185	7193	7202	7210	7218	7226	7235	1	2	2	3	4	5	6	7	7
53	7243	7251	7259	7267	7275	7284	7292	7300	7308	7316	1	2	2	3	4	5	6	6	7
54	7324	7332	7340	7348	7356	7364	7372	7380	7388	7396	1	2	2	3	4	5	6	6	7
55	7404	7412	7419	7427	7435	7443	7451	7459	7466	7474	1	2	2	3	4	5	5	6	7
56	7482	7490	7497	7505	7513	7520	7528	7536	7543	7551	1	2	2	3	4	5	5	6	7
57	7559	7566	7574	7582	7589	7597	7604	7612	7619	7627	1	2	2	3	4	5	5	6	7
58	7634	7642	7649	7657	7664	7672	7679	7686	7694	7701	1	1	2	3	4	4	5	6	7
59	7709	7716	7723	7731	7738	7745	7752	7760	7767	7774	1	1	2	3	4	4	5	6	7
60	7782	7789	7796	7803	7810	7818	7825	7832	7839	7846	1	1	2	3	4	4	5	6	6
61	7853	7860	7868	7875	7882	7889	7896	7903	7910	7917	1	1	2	3	4	4	5	6	6
62	7924	7931	7938	7945	7952	7959	7966	7973	7980	7987	1	1	2	3	3	4	5	6	6
63	7993	8000	8007	8014	8021	8028	8035	8041	8048	8055	1	1	2	3	3	4	5	5	6
64	8062	8069	8075	8082	8089	8096	8102	8109	8116	8122	1	1	2	3	3	4	5	5	6
65	8129	8136	8142	8149	8156	8162	8169	8176	8182	8189	1	1	2	3	3	4	5	5	6
66	8195	8202	8209	8215	8222	8228	8235	8241	8248	8254	1	1	2	3	3	4	5	5	6
67	8261	8267	8274	8280	8287	8293	8299	8306	8312	8319	1	1	2	3	3	4	5	5	6
68	8325	8331	8338	8344	8351	8357	8363	8370	8376	8382	1	1	2	3	3	4	4	5	6
69	8388	8395	8401	8407	8414	8420	8426	8432	8439	8445	1	1	2	2	3	4	4	5	6

TABLE OF LOGARITHMS.

Nat. Numb.	0	1	2	3	4	5	6	7	8	9	Proportional Parts 1	2	3	4	5	6	7	8	9
70	8451	8457	8463	8470	8476	8482	8488	8494	8500	8506	1	1	2	2	3	4	4	5	5
71	8513	8519	8525	8531	8537	8543	8549	8555	8561	8567	1	1	2	2	3	4	4	5	5
72	8573	8579	8585	8591	8597	8603	8609	8615	8621	8627	1	1	2	2	3	4	4	5	5
73	8633	8639	8645	8651	8657	8663	8669	8675	8681	8686	1	1	2	2	3	4	4	5	5
74	8692	8698	8704	8710	8716	8722	8727	8733	8739	8745	1	1	2	2	3	4	4	5	5
75	8751	8756	8762	8768	8774	8779	8785	8791	8797	8802	1	1	2	2	3	3	4	5	5
76	8808	8814	8820	8825	8831	8837	8842	8848	8854	8859	1	1	2	2	3	3	4	5	5
77	8865	8871	8876	8882	8887	8893	8899	8904	8910	8915	1	1	2	2	3	3	4	4	5
78	8921	8927	8932	8938	8943	8949	8954	8960	8965	8971	1	1	2	2	3	3	4	4	5
79	8976	8982	8987	8993	8998	9004	9009	9015	9020	9025	1	1	2	2	3	3	4	4	5
80	9031	9036	9042	9047	9053	9058	9063	9069	9074	9079	1	1	2	2	3	3	4	4	5
81	9085	9090	9096	9101	9106	9112	9117	9122	9128	9133	1	1	2	2	3	3	4	4	5
82	9138	9143	9149	9154	9159	9165	9170	9175	9180	9186	1	1	2	2	3	3	4	4	5
83	9191	9196	9201	9206	9212	9217	9222	9227	9232	9238	1	1	2	2	3	3	4	4	5
84	9243	9248	9253	9258	9263	9269	9274	9279	9284	9289	1	1	2	2	3	3	4	4	5
85	9294	9299	9304	9309	9315	9320	9325	9330	9335	9340	1	1	2	2	3	3	4	4	5
86	9345	9350	9355	9360	9365	9370	9375	9380	9385	9390	1	1	2	2	3	3	4	4	5
87	9395	9400	9405	9410	9415	9420	9425	9430	9435	9440	0	1	1	2	2	3	3	4	4
88	9445	9450	9455	9460	9465	9469	9474	9479	9484	9489	0	1	1	2	2	3	3	4	4
89	9494	9499	9504	9509	9513	9518	9523	9528	9533	9538	0	1	1	2	2	3	3	4	4
90	9542	9547	9552	9557	9562	9566	9571	9576	9581	9586	0	1	1	2	2	3	3	4	4
91	9590	9595	9600	9605	9609	9614	9619	9624	9628	9633	0	1	1	2	2	3	3	4	4
92	9638	9643	9647	9652	9657	9661	9666	9671	9675	9680	0	1	1	2	2	3	3	4	4
93	9685	9689	9694	9699	9703	9708	9713	9717	9722	9727	0	1	1	2	2	3	3	4	4
94	9731	9736	9741	9745	9750	9754	9759	9763	9768	9773	0	1	1	2	2	3	3	4	4
95	9777	9782	9786	9791	9795	9800	9805	9809	9814	9818	0	1	1	2	2	3	3	4	4
96	9823	9827	9832	9836	9841	9845	9850	9854	9859	9863	0	1	1	2	2	3	3	4	4
97	9868	9872	9877	9881	9886	9890	9894	9899	9903	9908	0	1	1	2	2	3	3	4	4
98	9912	9917	9921	9926	9930	9934	9939	9943	9948	9952	0	1	1	2	2	3	3	4	4
99	9956	9961	9965	9969	9974	9978	9983	9987	9991	9996	0	1	1	2	2	3	3	3	4

TABLE OF ANTI-LOGARITHMS.

Logs.	0	1	2	3	4	5	6	7	8	9	Proportional Parts 1	2	3	4	5	6	7	8	9
.00	1000	1002	1005	1007	1009	1012	1014	1016	1019	1021	0	0	1	1	1	1	2	2	2
.01	1023	1026	1028	1030	1033	1035	1038	1040	1042	1045	0	0	1	1	1	1	2	2	2
.02	1047	1050	1052	1054	1057	1059	1062	1064	1067	1069	0	0	1	1	1	1	2	2	2
.03	1072	1074	1076	1079	1081	1084	1086	1089	1091	1094	0	0	1	1	1	1	2	2	2
.04	1096	1099	1102	1104	1107	1109	1112	1114	1117	1119	0	1	1	1	1	2	2	2	2
.05	1122	1125	1127	1130	1132	1135	1138	1140	1143	1146	0	1	1	1	1	2	2	2	2
.06	1148	1151	1153	1156	1159	1161	1164	1167	1169	1172	0	1	1	1	1	2	2	2	2
.07	1175	1178	1180	1183	1186	1189	1191	1194	1197	1199	0	1	1	1	1	2	2	2	2
.08	1202	1205	1208	1211	1213	1216	1219	1222	1225	1227	0	1	1	1	1	2	2	2	3
.09	1230	1233	1236	1239	1242	1245	1247	1250	1253	1256	0	1	1	1	1	2	2	2	3
.10	1259	1262	1265	1268	1271	1274	1276	1279	1282	1285	0	1	1	1	1	2	2	2	3
.11	1288	1291	1294	1297	1300	1303	1306	1309	1312	1315	0	1	1	1	2	2	2	2	3
.12	1318	1321	1324	1327	1330	1334	1337	1340	1343	1346	0	1	1	1	2	2	2	2	3
.13	1349	1352	1355	1358	1361	1365	1368	1371	1374	1377	0	1	1	1	2	2	2	3	3
.14	1380	1384	1387	1390	1393	1396	1400	1403	1406	1409	0	1	1	1	2	2	2	3	3
.15	1413	1416	1419	1422	1426	1429	1432	1435	1439	1442	0	1	1	1	2	2	2	3	3
.16	1445	1449	1452	1455	1459	1462	1466	1469	1472	1476	0	1	1	1	2	2	2	3	3
.17	1479	1483	1486	1489	1493	1496	1500	1503	1507	1510	0	1	1	1	2	2	2	3	3
.18	1514	1517	1521	1524	1528	1531	1535	1538	1542	1545	0	1	1	1	2	2	2	3	3
.19	1549	1552	1556	1560	1563	1567	1570	1574	1578	1581	0	1	1	1	2	2	3	3	3
.20	1585	1589	1592	1596	1600	1603	1607	1611	1614	1618	0	1	1	1	2	2	3	3	3
.21	1622	1626	1629	1633	1637	1641	1644	1648	1652	1656	0	1	1	2	2	2	3	3	3
.22	1660	1663	1667	1671	1675	1679	1683	1687	1690	1694	0	1	1	2	2	2	3	3	3
.23	1698	1702	1706	1710	1714	1718	1722	1726	1730	1734	0	1	1	2	2	2	3	3	4
.24	1738	1742	1746	1750	1754	1758	1762	1766	1770	1774	0	1	1	2	2	2	3	3	4
.25	1778	1782	1786	1791	1795	1799	1803	1807	1811	1816	0	1	1	2	2	2	3	3	4
.26	1820	1824	1828	1832	1837	1841	1845	1849	1854	1858	0	1	1	2	2	3	3	3	4
.27	1862	1866	1871	1875	1879	1884	1888	1892	1897	1901	0	1	1	2	2	3	3	3	4
.28	1905	1910	1914	1919	1923	1928	1932	1936	1941	1945	0	1	1	2	2	3	3	4	4
.29	1950	1954	1959	1963	1968	1972	1977	1982	1986	1991	0	1	1	2	2	3	3	4	4

TABLE OF ANTI-LOGARITHMS.

Logs	0	1	2	3	4	5	6	7	8	9	Proportional Parts 1	2	3	4	5	6	7	8	9
.30	1995	2000	2004	2009	2014	2018	2023	2028	2032	2037	0	1	1	2	2	3	3	4	4
.31	2042	2046	2051	2056	2061	2065	2070	2075	2080	2084	0	1	1	2	2	3	3	4	4
.32	2089	2094	2099	2104	2109	2113	2118	2123	2128	2133	0	1	1	2	2	3	3	4	4
.33	2138	2143	2148	2153	2158	2163	2168	2173	2178	2183	0	1	1	2	2	3	3	4	4
.34	2188	2193	2198	2203	2208	2213	2218	2223	2228	2234	1	1	2	2	3	3	4	4	5
.35	2239	2244	2249	2254	2259	2265	2270	2275	2280	2286	1	1	2	2	3	3	4	4	5
.36	2291	2296	2301	2307	2312	2317	2323	2328	2333	2339	1	1	2	2	3	3	4	4	5
.37	2344	2350	2355	2360	2366	2371	2277	2382	2388	2393	1	1	2	2	3	3	4	4	5
.38	2399	2404	2410	2415	2421	2427	2432	2438	2443	2449	1	1	2	2	3	3	4	4	5
.39	2455	2460	2466	2472	2477	2483	2489	2495	2500	2500	1	1	2	2	3	3	4	5	5
.40	2512	2518	2523	2529	2535	2541	2547	2553	2559	2564	1	1	2	2	3	4	4	5	5
.41	2570	2576	2582	2588	2594	2600	2606	2612	2618	2624	1	1	2	2	3	4	4	5	5
.42	2630	2636	2642	2649	2655	2661	2667	2673	2679	2685	1	1	2	2	3	4	4	5	6
.43	2692	2698	2704	2710	2716	2723	2729	2735	2742	2748	1	1	2	3	3	4	4	5	6
.44	2754	2761	2767	2773	2780	2786	2793	2799	2805	2812	1	1	2	3	3	4	4	5	6
.45	2818	2825	2831	2838	2844	2851	2858	2864	2871	2877	1	1	2	3	3	4	5	5	6
.46	2884	2891	2897	2904	2911	2917	2924	2931	2938	2944	1	1	2	3	3	4	5	5	6
.47	2951	2958	2965	2972	2979	2985	2992	2999	3006	3013	1	1	2	3	3	4	5	5	6
.48	3020	3027	3034	3041	3048	3055	3062	3069	3076	3083	1	1	2	3	4	4	5	6	6
.49	3090	3097	3105	3112	3119	3126	3133	3141	3148	3155	1	1	2	3	4	4	5	6	6
.50	3162	3170	3177	3184	3192	3199	3206	3214	3221	3228	1	1	2	3	4	4	5	6	7
.51	3236	3243	3251	3258	3266	3273	3281	3289	3296	3304	1	2	2	3	4	5	5	6	7
.52	3311	3319	3327	3334	3342	3350	3357	3365	3373	3381	1	2	2	3	4	5	5	6	7
.53	3388	3396	3404	3412	3420	3428	3436	3443	3451	3459	1	2	2	3	4	5	6	6	7
.54	3467	3475	3483	3491	3499	3508	3516	3524	3532	3540	1	2	2	3	4	5	6	6	7
.55	3548	3556	3565	3573	3581	3589	3597	3606	3614	3622	1	2	2	3	4	5	6	7	7
.56	3631	3639	3648	3656	3664	3673	3681	3690	3698	3707	1	2	3	3	4	5	6	7	8
.57	3715	3724	3733	3741	3750	3758	3767	3776	3784	3793	1	2	3	3	4	5	6	7	8
.58	3802	3811	3819	3828	3837	3846	3855	3864	3873	3882	1	2	3	4	4	5	6	7	8
.59	3890	3899	3908	3917	3296	3936	3945	3954	3963	3972	1	2	3	4	5	5	6	7	8

TABLE OF ANTI-LOGARITHMS.

Logs.	0	1	2	3	4	5	6	7	8	9	PROPORTIONAL PARTS. 1	2	3	4	5	6	7	8	9
60	3981	3990	3999	4009	4018	4027	4036	4046	4055	4064	1	2	3	4	5	6	6	7	8
61	4074	4083	4093	4102	4111	4121	4130	4140	4150	4159	1	2	3	4	5	6	7	8	9
.62	4169	4178	4188	4198	4207	4217	4227	4236	4246	4256	1	2	3	4	5	6	7	8	9
.63	4266	4276	4285	4295	4305	4315	4325	4335	4345	4355	1	2	3	4	5	6	7	8	9
.64	4365	4375	4385	4395	4406	4416	4426	4436	4446	4457	1	2	3	4	5	6	7	8	9
.65	4467	4477	4487	4498	4508	4519	4529	4539	4550	4560	1	2	3	4	5	6	7	8	9
.66	4571	4581	4592	4603	4613	4624	4634	4645	4656	4667	1	2	3	4	5	6	7	9	10
.67	4677	4688	4699	4710	4721	4732	4742	4753	4764	4775	1	2	3	4	5	7	8	9	10
.68	4786	4797	4808	4819	4831	4842	4853	4864	4875	4887	1	2	3	4	6	7	8	9	10
.69	4898	4909	4920	4932	4943	4955	4966	4977	4989	5000	1	2	3	5	6	7	8	9	10
.70	5012	5023	5035	5047	5058	5070	5082	5093	5105	5117	1	2	4	5	6	7	8	9	11
.71	5129	5140	5152	5164	5176	5188	5200	5212	5224	5236	1	2	4	5	6	7	8	10	11
.72	5248	5260	5272	5284	5297	5309	5321	5333	5346	5358	1	2	4	5	6	7	9	10	11
.73	5370	5383	5395	5408	5420	5433	5445	5458	5470	5483	1	3	4	5	6	8	9	10	11
.74	5495	5508	5521	5534	5546	5559	5572	5585	5598	5610	1	3	4	5	6	8	9	10	12
.75	5623	5636	5649	5662	5675	5689	5702	5715	5728	5741	1	3	4	5	7	8	9	10	12
.76	5754	5768	5781	5794	5808	5821	5834	5848	5861	5875	1	3	4	5	7	8	9	11	12
.77	5888	5902	5916	5929	5943	5957	5970	5984	5998	6012	1	3	4	5	7	8	10	11	12
.78	6026	6039	6053	6067	6081	6095	6109	6124	6138	6152	1	3	4	6	7	8	10	11	13
.79	6166	6180	6194	6209	6223	6237	6252	6266	6281	6295	1	3	4	6	7	9	10	11	13
80	6310	6324	6339	6353	6368	6383	6397	6412	6427	6442	1	3	4	6	7	9	10	12	13
81	6457	6471	6486	6501	6516	6531	6546	6561	6577	6592	2	3	5	6	8	9	11	12	14
82	6607	6622	6637	6653	6668	6683	6699	6714	6730	6745	2	3	5	6	8	9	11	12	14
.83	6761	6776	6792	6808	6823	6839	6855	6871	6887	6902	2	3	5	6	8	9	11	13	14
.84	6918	6934	6950	6966	6982	6998	7015	7031	7047	7063	2	3	5	6	8	10	11	13	15
.85	7079	7096	7112	7129	7145	7161	7178	7194	7211	7228	2	3	5	7	8	10	12	13	15
.86	7244	7261	7278	7295	7311	7328	7345	7362	7379	7396	2	3	5	7	8	10	12	13	15
.87	7413	7430	7447	7464	7482	7499	7516	7534	7551	7568	2	3	5	7	9	10	12	14	16
.88	7586	7603	7621	7638	7656	7674	7691	7709	7727	7745	2	4	5	7	9	11	12	14	16
.89	7762	7780	7798	7816	7834	7852	7870	7889	7907	7925	2	4	5	7	9	11	13	14	16

TABLE OF ANTI-LOGARITHMS.

Log.	0	1	2	3	4	5	6	7	8	9	Proportional Parts 1	2	3	4	5	6	7	8	9
.90	7943	7962	7980	7998	8017	8035	8054	8072	8091	8110	2	4	6	7	9	11	13	15	17
.91	8128	8147	8166	8185	8204	8222	8241	8260	8279	8299	2	4	6	8	9	11	13	15	17
.92	8318	8337	8356	8375	8395	8414	8433	8453	8472	8492	2	4	6	8	10	12	14	15	17
.93	8511	8531	8551	8570	8590	8610	8630	8650	8670	8690	2	4	6	8	10	12	14	16	18
.94	8710	8730	8750	8770	8790	8810	8831	8851	8872	8892	2	4	6	8	10	12	14	16	18
.95	8913	8933	8954	8974	8995	9016	9036	9057	9078	9099	2	4	6	8	10	12	15	17	19
.96	9120	9141	9162	9183	9204	9226	9247	9268	9290	9311	2	4	6	8	11	13	15	17	19
.97	9333	9354	9376	9397	9419	9441	9462	9484	9506	9528	2	4	7	9	11	13	15	17	20
.98	9550	9572	9594	9616	9638	9661	9683	9705	9727	9750	2	4	7	9	11	13	16	18	20
.99	9772	9795	9817	9840	9863	9886	9908	9931	9954	9977	2	5	7	9	11	14	16	18	20

GUIDE TO THE USE OF THE FOREGOING TABLES.

Logarithm	2080	3.3181	Logarithm	2.08	.3181
"	208	2.3181	"	.208	$\bar{1}$.3181
"	20.8	1.3181	"	.0208	$\bar{2}$.3181

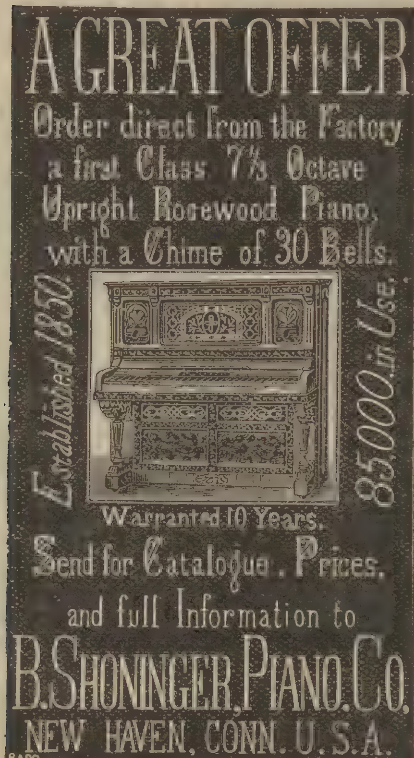
Find Logarithm of 4026.		Find Natural Number for Logarithm 3.2432.	
Logarithm 4020	3.6042	Number for Logarithm 3.2430	1750.
Proportional part for 6	6	Add proportional part for 2,	1.
Logarithm required	3.6048	Natural number required,	1751.

To Multiply by use of Logarithms: Add together the logarithms of the numbers to be multiplied; the sum is a logarithm whose natural number is the product required.

To Divide by use of Logarithms: Subtract the logarithm of the divisor from the logarithm of dividend; the difference is a logarithm whose natural number is the quotient required.

To Extract a Root by use of Logarithms: Divide the logarithm of the number (whose root is to be extracted) by the index of the root; the quotient is the logarithm of the required root.

To Raise a Number to any Power: Multiply the logarithm of the number (to be raised) by the index of the power; the product is the logarithm of the required number.



MUSIC HATH CHARMS.

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